MILL CREEK 2 AND 3 HYDROELECTRIC SYSTEMS HAER No. CA-2272
Mill Creek
Yucaipa vicinity
San Bernardino County
California

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

FIELD RECORDS

HISTORIC AMERICAN ENGINEERING RECORD
National Park Service
U.S. Department of Interior
1111 Jackson Street
Oakland, California 94607

HISTORIC AMERICAN ENGINEERING RECORD

MILL CREEK 2 AND 3 HYDROELECTRIC SYSTEMS

HAER No. CA-2272

Location: The Mill Creek 2 and 3 (MC 2 and 3) Hydroelectric Systems are located in San Bernardino County, just south of California State Route 38 (SR 38). Their western boundary is about 2/3 of a mile to the east of the eastern boundary of the City of Redlands. Yucaipa is the nearest city, located several miles to the south of the MC 2 and 3 powerhouse location. The first of the Mill Creek facilities, Mill Creek 1, is situated two miles southwest of MC 2 and 3. Most of the property is located within the San Bernardino National Forest, with a small western section situated on unincorporated San Bernardino County land. Mill Creek runs through the property, and is the source of water that runs MC 2 and 3. Mountain Home Creek and Monkeyface Falls are located north of Mill Creek, providing supplemental water for MC 2 until it stopped operations. The hydroelectric systems are located on portions of the USGS topographic maps Yucaipa (Sections 7, 8, 13, 17 and 18; T.1S., R.1W.) and Forest Falls (Section 8, 9, 10, 11, 12, 13, 14, 15, 16 and 17; T.1S., R.1W.).

Date of Construction: #2: 1898-1899, #3: 1899-1903

Builder: Redlands Electric Light and Power Company

Present Owner: Southern California Edison Company
(fee ownership and easements)
2244 Walnut Grove Avenue
Rosemead, CA 91770

Use: Hydroelectric power generation facility

Significance: The Mill Creek 2 and 3 Hydroelectric Systems are significant as early examples of high-head hydroelectric systems that still exist today in the United States. These were also some of the first commercial three-phase alternating current stations in California. Mill Creek 1 was the first to use this system in California and possibly the United States. This became the industry standard. Previous systems used either single-phase alternating current or direct current. The Mill Creek facilities also played an important role in the growth and development of the City of Redlands.

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Date: May, 2010

Part I: Description

General History of Hydroelectric Systems

Hydroelectricity is the production of electrical energy through the use of the gravitational force of falling or flowing water, a technology that has existed since the nineteenth century. The knowledge of applying water power for industrial uses, however, has existed for thousands of years. The Chinese and Egyptians, for example, were using water wheels in rivers in order to raise the water levels to irrigate land and to also provide the energy to perform simple tasks such as grinding corn.[1]

The Industrial Revolution began the process that led to the development of the hydroelectric system. Originating in Great Britain during the late eighteenth century, the Industrial Revolution had a tremendous impact on people's lives as industrialized nations moved away from a manual labor based economy to one that was machine and manufacturing based. The movement then spread throughout Europe and the United States. One of the results was the invention of steam and internal combustion engines and the creation of electrical energy. The first dynamo or electrical generator was perfected in 1867. The first water wheel used to generate electricity was built in 1882 in the United States. In the 1880s, experiments were being made in the United States and Europe to transmit electricity over long distances. By the late nineteenth and early twentieth centuries, generation and transmission technologies became advanced enough so that electricity became the established choice for energy. It was during that time that power generating systems, such as those in Mill Creek, were established using available nearby water sources.

There are basically two types of hydroelectric systems. Low-head uses a large amount of water collected using dams, and falls a relatively short distance to operate the system. This is more common in the eastern part of the United States where water is abundant and the topography is generally low. High-head uses a lower volume of water and travels through channels. It relies on greater topographic relief for the water to fall, sometimes as much as several thousand feet. The water goes through pipes to create the pressure necessary to turn the turbines.[2] MC 2 and 3 are high-head systems.

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[1] David B. Rushmore and Eric A. Lof, *Hydro-Electric Power Stations*, New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Limited, 1923, 1.

[2] Thomas T. Taylor, "Photographs, and Written Historical and Descriptive Data: Bishop Creek Hydroelectric System, Bishop Creek, Bishop Vicinity, Inyo County, California, HAER No. CA-145," February 7, 1994; "Redlands Electric Light & Power Co., Edition Electric Co. of Los Angeles, Mill Creek Powerhouses," *National Register of Historic Places Inventory – Nomination Form*, April 30, 1985, item number 7, 1.

***Basic Components and Operation of Hydroelectric Systems*[3]**

1. Water from a natural channel is diverted using a diversion dam, headgates, screens and a spillway. The headgates regulate the flow of water, while the screens prevent debris from entering the water conduit. This portion of the system is known as the intake.
2. Following the intake is a water conduit or canal system consisting of open channels (i.e. flumes), tunnels, siphons and/or pipes. The length of this system varies greatly depending on the area's topography and the amount of water pressure (i.e. "hydrostatic head") to be developed. Sluice and sandboxes are usually built in the canal system to allow sand and gravel to settle out of the water. If this is not done, the abrasiveness of the sandy water would rapidly wear out the water wheel and related equipment.
3. The system then connects to a forebay, which is a reservoir that feeds the pressure pipe known as the penstock that connects to the powerhouse. The forebay is located at a higher elevation so that the water can fall at a great pressure to operate the system. The forebay helps to regulate the water flowing into the penstock and allows the water to settle before entering the penstock so that any additional silt that may have entered the conduit would be kept out. The penstock is built as nearly vertical as conditions will allow, providing the water pressure needed to operate the water wheels or turbines of the powerhouse below.
4. A powerhouse is located at the bottom of the penstock. This is a building within which is housed the electrical power generation and distribution equipment. The machinery used to generate the electricity is referred to as a "unit," and includes a water wheel or turbine, a governor to control the water wheel's loading, an electrical generator and an "exciter." The exciter may serve more than one unit and provides the direct current to energize the electromagnets within the larger alternating current generators. The powerhouse also includes the distribution equipment used to initiate the transmission of the electricity. This consists of switches, circuit breakers and related controls which are connected to a transformer. The transformer increases the voltage so that the power can be transmitted over long distances. The earliest power generation systems did not have transformers and transmitted power directly at the relatively low voltages produced by the generators. The powerhouse also contains a variety of other apparatus used in the operation of the system. This often includes a small unit to operate the powerhouse lights and equipment, as well as telephone links with other system components. A tailrace, which consists of tunnels, runs underneath the building to remove the spent water from the system. This generally flows back into a natural water source, although it can also be used to supply water for another hydroelectric system

   Other buildings associated with the operation of the hydroelectric system are usually located in close proximity to the powerhouse. These can include administration facilities, garages, stables, housing for system personnel, equipment storage sheds, pump houses, machine shops, oil houses and chlorine storage sheds.

[3] Most of this section was taken from "Redlands Electric Light & Power Co., Edition Electric Co. of Los Angeles, Mill Creek Powerhouses," *National Register of Historic Places Inventory – Nomination Form*, April 30, 1985.

5. A transmission line carries the power to users.

Location and Overview of Mill Creek 2 and 3
The MC 2 and 3 facilities are high-head hydroelectric systems located in a mountainous area east of the City of Redlands in San Bernardino County, California, just south of SR 38. MC 2 and 3 are owned and operated by Southern California Edison (SCE), and located in the San Bernardino National Forest, with a small western section situated on unincorporated San Bernardino County land. MC 2 construction started in 1899 and was completed the following year. Work on MC 3 began in 1899 and completed in 1903. They are both situated in Mill Creek Canyon, with altitudes that range from 2,900 to 4,850 feet. MC 2 and 3's western boundary is about 2/3 of a mile to the east of the eastern boundary of the City of Redlands. Yucaipa is the nearest city, located several miles to the south of the MC 2 and 3 powerhouse. The first of the Mill Creek facilities, Mill Creek 1 (MC 1),[4] is located further below along Mill Creek Canyon, about two miles southwest of MC 2 and 3. MC 2 has been non-operational since 1992, although much of its features still remain, while MC 3 is still operating. All three systems are accessible off of SR 38.

Mill Creek is the source of water that runs MC 2 and 3. The creek originates near Galena Peak in the eastern San Bernardino Mountains. The water then flows into the Santa Ana River at the Santa Ana Wash, located just north of Redlands and it then heads towards the San Bernardino Valley.[5] Mountain Home Creek was also a supplemental source for MC 2. Its intake is located in the middle of the Mountain Home Village, a residential community that was established in the 1920s. Water from Monkeyface Falls, which originates from Monkeyface Creek, was also taken from this intake until the 1970s. Each system has separate intakes, flowlines, sandboxes and forebays to collect and process the water, but then flow west into the same powerhouse to create electrical energy. They power an electrical system that originally served the City of Redlands, but later also provided bulk electricity for the cities of Colton and Riverside.

Description of the Mill Creek 2 and 3 Systems
The Mill Creek systems operate under the Federal Energy Regulatory Commission license number 1934. The segments that are part of the license are described in the subsections as listed below:

Mill Creek 2: Mountain Home Creek intake, Mill Creek 2 intake, sandbox, lower flowline, forebay, penstock, generator, and exciters. For additional information on each feature please see Historical American Engineering Records for the Mountain Home Creek intake, Mill Creek 2 intake, sandbox, lower flowline, forebay, penstock, generator, and exciters (HAER Nos. CA-2272-A – CA-2272-H).

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[4] Mill Creek 1 was the first of the Mill Creek hydroelectric systems, and was completed in 1893. It was the first commercial three-phase alternating current station. The three-phase system has become standard. Mill Creek 1 is still standing and operational.
[5] Philip de Barros and Carmen Weber, "Cultural Resources Inventory and Evaluation of the Mill Creek Hydroelectric Project FERC Project No 1934," March 1993, 2-1.

Mill Creek 3: Mill Creek 3 intake, flume keeper's cottage (ruins), Mill Creek 3 domestic water tank, sandbox, upper flowline, forebay, penstock, and generators. For additional information on each feature please see Historical American Engineering Records for Mill Creek 3 intake, flume keeper's cottage (ruins), Mill Creek 3 domestic water tank, sandbox, upper flowline, forebay, penstock, and generators (HAER Nos. CA-2272-I – CA-2272-P).

Mill Creek 2 and 3: Powerhouse. For additional information on the Mill Creek 2 and 3 Powerhouse please see the Historical American Engineering Record for the Mill Creek 2 and 3 Powerhouse (HAER No. CA-2272-Q).

Mill Creek 2 and 3: Switch rack, garage, chlorine storage shed, powerhouse potable water tank, walls with rubble stones laid in concrete (including remnants of workers cottages), ice house, cottage potable water tank, and H. H. Sinclair monument. For additional information on each feature please see Historical American Engineering Records Switch rack, garage, chlorine storage shed, powerhouse potable water tank, rubble stone walls and cottage sites, ice house, cottage potable water tank, and H. H. Sinclair monument (HAER Nos. CA-2272-R – CA-2272-Y).

Mill Creek 2

There are two intakes associated with Mill Creek 2 (MC 2). The main one is located on the south side of Mill Creek, with Mountain Home Village situated just on the other side of the creek. The water from MC 2 was diverted using a tunnel about 400 feet long, with the upper end passing under the Mill Creek bed 18 feet below the surface. The water then went into the intake which consists of a poured concrete structure built into the hill on the south side of the creek. At the east side of the intake structure is a room, formerly used to house water level monitoring equipment, which has a door opening but with no door. It faces onto a concrete slab. Located on the west side of the intake is a headgate that currently has only the top section exposed above ground. The diversion dam is likely still intact, but is buried.

The water then flowed west into another part of the intake consisting of a rectangular poured concrete structure covered with wood planks called a water control box, which allowed the operators to use weir boards to set the intake water level. The intake could be kept full of water at this box, while shutting down the rest of the system.[6] Located direct adjacent to the west is a rubble stone structure with a round floor plan called a rock drop. It also has wood planks covering the opening at the top. Water, along with rocks and gravel, came into this deep structure. The rocks and gravel dropped down as the water continued to flow through. The water then entered another larger rectangular structure surrounded by a chain link fence on all sides and top. A leaf rake and a fish wheel are located within this structure. The wheel tines on the outer diameter of the leaf rake would move through the slots in a grate, and remove leave and debris. The fish wheel is covered with a screen mesh that fit tight to the walls and floor so that

[6] Dean Caskey, Civil Crew Foreman, Eastern Hydro Division, Southern California Edison, telephone interview by Christeen Taniguchi, November 18, 2008.

fish would not be able to get into the system. The rotating wheel would allow the wheel to clean itself and helps the water to flow.[7]

The second MC 2 intake is located at Mountain Home Creek, 3,650 feet above sea level, and near the intersection of Kilkare Road and Coulter Pine Drive. The Mountain Home Creek intake is located within a residential neighborhood called Mountain Home Village that was established before the 1920s. The intake consists of a poured concrete structure with an angled roof clad with wood planks. The water flows south under a rubble stone wall with a concrete cap/walkway. Water from Monkeyface Falls also flowed into the east end of the intake structure. There was originally a dam at this location, but this was taken down in the late 1990s. From the intake, the water originally went into a tunnel located below ground, although this collapsed in 1906 and was replaced with a wooden flume ten years later. This flume was then replaced with a concrete pipe,[8] which continued to be used until this system was closed down. The water system then continued into aboveground 12 inch steel pipes that crossed over Mill Creek and linked to the MC 2 intake at Mill Creek.[9] These pipes have broken apart, although sections are still in the creek bed.

The Mill Creek intake combined the water from Mill Creek as well as Mountain Home Creek and Monkeyface Falls. Once the water flowed through the intake, the water continued in 18 inch concrete pipes then into steel pipes towards the *sandbox* which is 22 feet (east to west) by 50 feet (north to south). There are five settling basins with concrete cross walls that vary in depth from five to eight feet.[10] Each basin is v-shaped in order to help collect the sand, which is then sluiced through gates at the lower end of the sandbox. The flume passes along the upper side so that the water can enter the five basins, passing through them via wide crested weirs. Because of the large cross section, the water loses velocity, thus allowing the sand to collect at the bottom before the water continues to the pipe line. There is a sixth basin that is smaller than the other five. This basin collects water that is poured into the sandbox via a steel pipe located at the north end of the east side of the structure. Six drain gates line the north edge of the sandbox, one for each basin. The water then leaves the west end of the sandbox through a four foot wide concrete section that links to concrete pipes below.

The *lower flowline* serviced MC 2. The original flowline consisted of 11,334.2 feet of concrete laid in a covered trench, 1,692.7 feet of concrete pipe laid through tunnels, 1,971.1 feet of wooden flume and 226.5 feet of open ditch.[11] There were 22 wooden flumes, ranging in length from 22 to 400 feet, with an approximate 16 feet span.[12] The flume box was made of redwood

[7] Darrell W. Heinrich, Project Manager, Eastern Hydro Division, Southern California Edison, telephone interview by Christeen Taniguchi, November 18, 2008.
[8] "Redlands Electric Light & Power Co., Edition Electric Co. of Los Angeles, Mill Creek Powerhouses," *National Register of Historic Places Inventory – Nomination Form*, April 30, 1985, item number 7, 10.
[9] "Redlands Electric Light & Power Co., Edition Electric Co. of Los Angeles, Mill Creek Powerhouses," op. cit. item number 7, 10.
[10] Frederick Hall Fowler, *Hydroelectric Power Systems of California and Their Extensions into Oregon and Nevada, Water-Supply Paper 493*, Washington, D. C.: Government Printing Office, 1923, 603.
[11] Ibid., 603.
[12] George P. Low, "The Generating, Transmission and Distribution Systems of The Edison Electric Company of Los Angeles, Cal.," *The Journal of Electricity, Power and Gas*, vol. XIII, no. 1, January, 1903, 22.

and placed longitudinally to the water flow. Flumes in exposed areas were protected against landslides and other damage with wood planks. In addition to the flume located between the intake tunnel and the sandbox, others were situated below the sandbox. The flowline also went over the Cottage Canyon natural spillway. No wood flumes remain today. The concrete pipes were made using the gravel and sand taken from the Mill Creek wash, and Portland cement made at a plant in Colton, California. The pipes are located two to three feet underground, and were maintained using manholes located at 500 feet intervals. These manholes still exist. Sections of this system were later replaced with aboveground steel pipes and squared concrete ditches with wood planks.[13]

The flowline continues west and connects to the *forebay* for MC 2. The forebay is an aboveground structure made of poured concrete and rubble stone walls. It is 20 feet by 17 feet inside, and five to ten feet deep. The water entered it at its northeast corner from a concrete box flume that has a steeply descending wood spillway flume located at its north end. There is also a waste flume for overflow from the forebay.[14]

The water leaves the forebay at its west end and connects to the *penstock*. The MC 2 penstock is 1,411 feet long, and is located underground and thus not visible. This is a steel pipe that has an 18 inch diameter, and was made with double-riveted longitudinal seams and single-riveted round seams. The pipes were double-dipped in asphaltum to prevent corrosion. They were laid three to six feet deep and backfilled with earth and rock. There were also heavy concrete anchors at five points of the line. These anchors were dovetailed into the rock at the sides and bottoms of the trenching in order to keep the pipes from moving and buckling. The main pipe then divided into three pipes as it neared the powerhouse. Two of the three pipes are 13 inches in diameter and brought water to the two generators, while the other one is six inches in diameter and provided water for the two exciters.[15]

Mill Creek 3

The water for Mill Creek 3 (MC 3) originates from Mill Creek. The MC 3 *intake* features are situated on the north side of the creek. The water is diverted from the creek through a concrete *diversion dam*, which is located about 5,000 feet above sea level. The dam consists of a diagonally placed concrete wall that deflects the water flow towards some tunnel headgates at the north bank of the creek. There is an ogee section of the headgate wall that creates a spillway. Additional water also comes from the Redlands Water Company pump #4, which also goes into the Mill Creek line. There are several similar pumps that feed into this system as well, which are a result of an agreement made between the Redlands Water Company and Southern California Edison (SCE). In the 1960s, SCE made an agreement with the water company to run the water company pumps and to provide the electricity to operate its machinery.[16]

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[13] Philip de Barros and Carmen Weber, "Cultural Resources Inventory and Evaluation of the Mill Creek Hydroelectric Project FERC Project No 1934," March 1993, 4-5.
[14] Low, op. cit., 24.
[15] Ibid., 22-23.

Water is admitted at the north end of the spillway through a screen and into the concrete headgate box. There is a leaf rack used to keep debris out of the dammed area. There was once a fish wheel located directly east of the trash rack, but it has been removed. The circular scars from its use, however, remain in the adjacent concrete wall. There is a stilling well with a USGS water gauge near the former location of the fish wheel. The intake pond also has a drain gate used to drain the feature when necessary for maintenance. There is a small concrete block office building where the log book is kept, located just north of the intake features. This building was constructed in about 2001, and replaced an original wood frame building with horizontal wood board cladding and a gabled roof.

There are a waste gate and headgate that admit water through another screen to the head of the first tunnel of the conduit. All the headworks gates are made of timber that slide into vertical grooves that are operated by hand winches. From the headgate, the water then goes into a tunnel then into a 3 by 4 feet flume that runs 125 feet long. Along the tunnel is a concrete rectangular pit which is covered over with wood framing.

It is likely that the pit may have been created for domestic water access because it is located near the ruins of the *flume keeper's cottage*. The cottage is located about half way between the intake and the sandbox. Although the flume keeper's cottage has been demolished, the masonry components of the foundation and chimney remain. These include the rubble stone fireplace and chimney laid in what appears to be a cementitious mortar. The former residence had a rubble stone foundation with a cement based mortar, and concrete coping. There is, however, a section of the foundation on the north side that is made of poured concrete, with concrete steps leading up to an earthen surface with a mature tree. These features, and the steel pipe handrails mounted on the outer boundaries of the foundation around most of the building, appear to have been added after the building was taken down. None of the roof or wall members remain. There are rubble stone and poured concrete retaining walls abutting the hillside to the east of the former residence.

After the water flows through the intake and past the flume keeper's cottage, the water then continues and flows into a concrete *sandbox*. It is the same design as the sandbox for MC 2, but is larger at 52 feet wide by 102 feet long.[17] It has eight chambers filled with water. The water is still, allowing the sand to settle to the bottom so that it does not harm the generator mechanisms. The water enters from the southeast corner of the sandbox through bypass gates. At the south end of the sandbox is a trash rack used to keep debris out of the sandbox. There is a leaf rack, which is no longer operational, used to keep leaves away from the sandbox screen. There is a stilling well used to monitor the water level in the sandbox. Eight drain gates line the western edge of the sandbox, one for each section of the structure. Connected to the southwest corner of the sandbox, and located west of the sandbox, is the get away channel. The feature is made of rubble stone embedded in concrete. The channel is used to drain excess sandbox water, and also to take water from the feature during maintenance. The water goes back into Mill Creek.

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[1] Darrell W. Heinrich, Project Manager, Eastern Hydro Division, Southern California Edison, telephone interview by Christeen Taniguchi, November 18, 2008.
[17] Frederick Hall Fowler, *Hydroelectric Power Systems of California and Their Extensions into Oregon and Nevada, Water-Supply Paper 493*, Washington, D. C.: Government Printing Office, 1923, 601.

The water then travels along what is called the *upper flowline*, which is nearly six miles long. It consists of concrete pipes, tunnels and inverted siphons. There are about 25,000 linear feet of concrete pipe, with about a 31 inch diameter on the inside. They line the 19 tunnels associated with MC 3. The outer walls of the pipes are about three inches thick, and made with Portland cement cast at the site. They are buried about three feet below the surface and are laid throughout the MC 3 tunnels, except where the siphons are located. Concrete manholes structures with metal lids are situated along the flow line and are used to do repairs and inspections.

The flowline then goes up onto Yucaipa Ridge and into the *forebay*. The ridge has an altitude of 5,300 feet.[18] From this point, the water conduit going back to the intake is 28,190 feet long.[19] This forebay is an irregularly shaped manmade body of water with a control tower located at the southern end. There is a concrete spillway located at the north end of the reservoir, used as a channel for any overflow of water. The spillway then links to a concrete box to transition to a metal aboveground pipe. This water continues to the Cottage Canyon natural spillway. There is a surge pipe on the west side of the pond. It is connected to a valve and an underground pipe used for drainage. The surge pipe also allows air in so as to relieve pressure in the pipes.

After leaving the reservoir, the water then goes through flowline pipes that are 8,400 feet long to eventually reach the cast iron *penstock*. This section of the flowline generally parallels the SCE access road, as well as the power and telephone lines. This flow of the water through the penstock is regulated by an upper penstock valve enclosure. The valve enclosure is connected to a bypass pipe which is embedded into the ground near the reservoir. The pipe is also used when the reservoir is drained for maintenance. There is a concrete core wall used as a dam located to the west of the reservoir. It is surrounded on either side with dirt. Located near the base of the hill near the powerhouse are control values for the lower penstock.

The processed water then flows down a hill through the penstock (alongside the penstock to the south for MC 2) towards a shared powerhouse. Flowing down the hill speeds up the water and creates the needed pressure for the powerhouse equipment. The MC 3 penstock has 24' and 26' diameter lap riveted pipes. Its static head is 1,905 feet. When it nears the powerhouse, the penstock branches into two then four pipelines. The pipes are painted with asphaltum inside and outside to protect against damage.[20] In addition, there are concrete thrust blocks situated to keep the pipes in place and from sliding down the hill.

Part II: Historical Context

MC 2 and 3 are today part of the vast SCE system. Like many similar plants, however, Mill Creek was founded by a small electrical company, the Redlands Electric Light and Power

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[18] Philip de Barros and Carmen Weber, "Cultural Resources Inventory and Evaluation of the Mill Creek Hydroelectric Project FERC Project No 1934," March 1993, 2-1.
[19] Fowler, op. cit., 601.
[20] George P. Low, "The Generating, Transmission and Distribution Systems of The Edison Electric Company of Los Angeles, Cal.," *The Journal of Electricity, Power and Gas*, vol. XIII, no. 1, January, 1903, 25.

Company. The company was incorporated in 1892 for the purpose of setting up a hydroelectric system (MC 1) to serve the City of Redlands and a radius of ten miles. As part of the process, the City of Redlands passed an ordinance on July 27 of that year to create a 50-year electric light franchise. The franchise was awarded to George H. Crofts, Henry Harbinson Sinclair, George Ellis and F. G. Feraud, who founded the Redlands Electric Light and Power Company. By the following month the power company was acquiring land and water rights on Mill Creek in preparation for a new hydroelectric facility. Sinclair, as well as Henry Fisher and Almerian W. Decker all played significant roles in developing the Redlands Electric Light and Power Company and Mill Creek hydroelectric facilities. Sinclair was the president and general manager, and Fisher was a prominent and wealthy Redlands resident.[21] Decker was the consulting engineer instrumental in creating a more efficient power generation system for the facility. Redlands started to grow in 1887 resulting in substantial business and residential development, and a very successful citrus industry.[22] Redlands was incorporated in 1888, with electricity playing a critical role in the city's future growth and prosperity.

Before MC 1 was constructed, electricity was still being developed with direct current (DC) as the normal offering from electric companies. The disadvantage of DC power is that it would not travel much beyond five miles from the generating plant. On the other hand, an alternative power system, alternating current (AC) had the capability to travel farther, but was a complex type of electricity that was more difficult to handle.[23] AC generators began to be used in the fall of 1886 at a commercial generating facility in Buffalo, New York, although this was a monophase system. Soon thereafter, AC systems were being used for incandescent lights. This was an improvement over the previous electrical system, such as the original Pasadena, Ventura and Santa Barbara lighting systems, which supplied arc lights.[24] By 1890, Pasadena, Santa Barbara, Highgrove and Visalia had adapted their existing arc light plants to alternating current to begin serving incandescent lighting.

Almerian W. Decker drew up the plans and specifications for this first Mill Creek facility. He was an electrical engineer originally from Cleveland, Ohio, who moved to Sierra Madre for his health. Prior to working on the Mill Creek facility, Decker had worked with the Pomona electrical plant while being employed by the San Antonio Light and Power Company where he had experience with AC generators, which was still a new technology in California.[25] The Pomona electrical plant was the first AC station in California, although it was a monophase type.[26] It provided incandescent lighting. However, Decker saw that the monophase system

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[21] George P. Low, "The Generating, Transmission and Distribution Systems of The Edison Electric Company of Los Angeles, Cal.," *The Journal of Electricity, Power and Gas*, vol. XIII, no. 1, January, 1903, 11.

[22] Ibid., 9.
[23] Mill Creek #1 Hydro Plant: America's First Commercial 3-Phase Alternating Current Power Plant," [circa late 1980s], [1].
[24] Noel B. Hinson, "Pioneering in Hydroelectric Generation and Transmission: Chronological History of all Plants of the Southern California Edison Company," 1956, 1-2.
[25] Hinson, op. cit., 5.
[26] Frederick Hall Fowler, *Hydroelectric Power Systems of California and Their Extensions into Oregon and Nevada, Water-Supply Paper 493*, Washington, D. C.: Government Printing Office, 1923, 1.

would not work to meet the power load demands for Redlands so instead he recommended a three-phase transmission system with a rated capacity of 400 kilowatts.

By using an AC system, the electricity for MC 1 could travel over 12 miles to reach Redlands, and the fact that MC 1 was a three-phase system meant that the large motors needed for the system could be operated successfully. Although the three-phase AC system had already been invented, the technology had not yet been applied commercially until Decker took it on. The three-phase system soon became standard practice for hydroelectric facilities,[27] although monophase generators were still being installed at smaller steam plants in as late as 1899.[28] Soon, California became one of the leading states using hydroelectric energy, along with Oregon and Colorado.

The Redlands Electric Light and Power Company requested bids for two three-phase generators and motors for the construction of MC 1. General Electric was the only domestic manufacturer willing to build this new type of system, which resulted in the first commercially successful three-phase AC generator called the "Type TY" generator. Construction for MC 1 began in December of 1892.[29] Decker unfortunately died during construction, so Orville H. Ensign took over the task of overseeing the work.[30] The facility opened on September 7, 1893,[31] with both Ensign and a representative from General Electric, Dr. Louis Bell, present. It had two 250-kilowatt machines that transmitted power over two three phase circuits, traveling 7 ½ miles to the City of Redlands.[32]

The energy created from MC 1 provided electric light and heat for both public and private use in Redlands, which had about 4,500 people at the time. Specifically, the electricity ran the elevators in the hotel, powered the refrigeration in several ice houses, and printed orange crate labels and newspapers. The streets were lit with electricity, and nearly all the houses and businesses had electricity. The Pacific Electric Railway street cars also operated using electricity generated from Mill Creek and the energy was also used for irrigation. Motors were installed to pump water for orange grove irrigation, which was one of the earliest known examples of this application.[33]

Perhaps most importantly, electricity allowed for the efficient manufacture of ice at the Union Ice Company, located in Mentone, about four miles east of Redlands.[34] This ice company established a 25-year contract with the Redlands Electric Light and Power Company, and was one of the largest ice manufacturers in the western part of the United States.[35] Union Ice

[27] "Redlands Electric Light & Power Co., Edition Electric Co. of Los Angeles, Mill Creek Power houses," op. cit., [2].
[28] Hinson, op. cit., Preamble 2.
[29] William A. Myers, *Iron Men and Copper Wires: A Centennial History of the Southern California Edison Company*, Glendale, California: Trans-Anglo Books, c1983, 1986, 29.
[30] Mill Creek #1 Hydro Plant: America's First Commercial 3-Phase Alternating Current Power Plant," op. cit., [2].
[31] Hinson, op. cit., 13.
[32] Fowler, op. cit., 534.
[33] Myers, op. cit., 30.
[34] Hinson, op. cit., 10-11.
[35] Low, op. cit., 10.

required 150 hp load of power, and justified the construction of the Mill Creek facility. Much of the ice was used to keep the oranges from the Redlands groves cool for storage and shipping. Although citrus was a growing industry at the time, without available fuel oil, the cost of making ice to transport the oranges was so high that it threatened to put Redlands citrus out of the competitive market. The potential for low cost hydroelectric power using nearby Mill Creek was the answer.[36]

MC 1 was a success and quickly recognized for its innovation and significance. The resulting electricity was inexpensive and readily available, helping not only the Redlands citrus industry, but the city itself to grow and prosper. This pioneering facility was also the first to use the three-phase AC system in California and possibly the United States, becoming an industry standard. By 1896, the Redlands Electric Light and Power Company started providing electricity in bulk to Colton and Riverside. The cities continued to run their own distribution systems. Electricity was also supplied to the City of Highland, providing electricity for their State insane asylum.[37] Improvements, including the addition of new transformers and Pelton wheels into the powerhouse, provided these needs.[38] The success and demand for electricity led to the installation of a third and later fourth generator at this facility.[39]

Further demands also led to the planning of MC 2 in 1898, to be located further up Mill Creek Canyon. This hydroelectric facility was designed by F. C. Finkle, who was chief engineer of the Redlands Electric Light and Power Company at the time. Construction of the system began on October 24, 1898, with the building of the power plant commencing in May in the following year.[40] The facility was then completed on September 1, 1899, and put into operation two months later.[41] It had two 250-kilowatt three-phase revolving field machines with about 11,500 volts potential,[42] running at 375 revolutions per minute. The water for this system was not only taken from Mill Creek, but also Mountain Home Creek and Monkeyface Falls.

When it first opened, MC 2 had the highest voltage AC generators on the West Coast. Like MC 1, the water provided electricity to businesses and residences throughout the City of Redlands. It also powered the arc street lights over the commercial streets. Meanwhile, the Redlands Electric Light & Power Company organized the Lytle Creek Light & Power Co. to develop the power potentials and rights of way of Lytle Creek and the California Power Company to begin work on Kern River.[43]

Continued growth led to the construction of MC 3, which began in the fall of 1899. Construction was initially slow until July of 1901, when the pace picked up. Just as MC 3 was being constructed, however, the Redlands Electric Light and Power Company was absorbed into the

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[36] "Mill Creek #1 Hydro Plant: America's First Commercial 3-Phase Alternating Current Power Plant," op. cit., [1].
[37] "Development of Electric Power," *Los Angeles Times*, January 1, 1899, A20.
[38] Low, op. cit., 12.
[39] "Mill Creek #1 Hydro Plant: America's First Commercial 3-Phase Alternating Current Power Plant," op. cit., [2].
[40] "Work on New Electric Plant," *Los Angeles Times*, March 27, 1899, 9.
[41] Fowler, op. cit., 601.
[42] Low, op. cit., 12.
[43] Fowler, op. cit., 535.

Edison Electric Company of Los Angeles in 1901.[44] In the following year, the Edison Electric Company of Los Angeles was reincorporated as the Edison Electric Company. By this time Edison had acquired other smaller electric companies such as the Pasadena Electric Light & Power Co., Santa Ana Gas & Electric Co. and the Lytle Creek Light & Power Co.[45] Reincorporation allowed for a higher bonding capacity, which was necessary due to the acquisition of these new companies.[46] The newly formed company then proceeded to connect the Mill Creek facilities to Santa Ana River No. 1, a large 33,000 volt-line that served Los Angeles.[47]

MC 3 opened for operation on March 18, 1903.[48] Its flowline, sandbox and forebay were located to the south of MC 2. The generators and other equipment, however, were housed in an extension of the existing MC 2 powerhouse. The addition was built to the north of the building. It began with its first 750 kilowatt, 750-volt unit. Three more identical units went into service in the following spring. At 1,905 feet, its penstock static head was the highest static head in the world from the time of construction until 1913.[49] In addition, MC 3 was distinctive in that unlike its predecessors, there were no wooden flumes. The flowline was made entirely of concrete pipe buried underground.[50]

The Southern California Edison name was incorporated on July 6, 1909, in Los Angeles.[51] The Mill Creek facilities became part of the vast SCE electrical empire that comprised 23 hydroelectric plants by the late 1930s.[52]

When the facilities were first completed, workers' residences were an important part of the function of the facilities. The facilities needed to be constantly supervised and overseen by the plant operators. Today, with most of the system nearly fully automated, around the clock staff is no longer necessary. Due to liability issues, the residences associated with MC 2 and 3 have been demolished. However, a few foundations of some of the buildings still remain. For example, at the Powerhouse location, there are rubble stone and concrete walls, and concrete steps, landings and foundation remnants. There is a more substantial residential ruin left standing between the MC 3 intake and sandbox. In addition to rubble stone walls and concrete steps, landings and foundations, the original rubble stone chimney and fireplace are still standing.

Unlike the MC 1 plant, which replaced its original generators in 1934,[53] the MC 2 and 3 powerhouse continued to use their original machines. However, on August 3, 1904, one

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[44] "Means Much to Redlands: Big Light and Power Deal Closed," *Los Angeles Times*, May 25, 1901, 8.
[45] Fowler, op. cit., 533.
[46] Ibid., 536.
[47] Ibid., 536.
[48] Ibid., 601.
[49] Hinson, op. cit., 28.
[50] Ibid., 28.
[51] Ibid., 42.
[52] Smith, Wesley, The March of Finance: Increase in Gross and Net Earnings of Southern California Edison for 1939 Sighted by President Bauer," *Los Angeles Times*, August 15, 1939, 15.
[53] Myers, op. cit., 31.

replacement unit was installed for MC 2. In addition, one of the MC 3's 750-kilowatt generators was removed in January 1935, and installed at MC 1.[54] MC 2 has not been in operation since 1992 when it was damaged during floods. MC 3 is still operating, using the original generators in the original powerhouse.

Part III: Sources of Information

Barros, Philip de and Carmen Weber. "Cultural Resources Inventory and Evaluation of the Mill Creek Hydroelectric Project FERC Project No 1934," March 1993.

"Big Deal Completed: Merger of Subsidiary Organizations of the Edison Electric Company Finally Consummated and Bonds Delivered," *Los Angeles Times*. November 8, 1902. 12.

Caskey, Dean, Civil Crew Foreman, Eastern Hydro Division, Southern California Edison. Personal interview by Christeen Taniguchi. June 3, 2008.

"Country Life: Water Power," *Los Angeles Times*. August 15, 1895. 15.

"Development of Electric Power," *Los Angeles Times*. January 1, 1899. A20.

Doble, Robert McF., Member of the Technical Society of the Pacific Coast. "Hydro- Electric Power Development and Transmission in California," *Journal of the Association of Engineering Societies*. Vol. 2272IV, no. 3, March 1905.

Eley, F. L. "Historical Notes [of Southern California Edison Company]," May 27, 1937.

Fowler, Frederick Hall. *Hydroelectric Power Systems of California and Their Extensions into Oregon and Nevada, Water-Supply Paper 493*. Washington, D. C.: Government Printing Office, 1923.

Heinrich, Darrell W., Project Manager, Eastern Hydro Division, Southern California Edison. Telephone interview by Christeen Taniguchi. November 18, 2008.

Hinson, Noel B. "Pioneering in Hydroelectric Generation and Transmission: Chronological History of all Plants of the Southern California Edison Company, 1956.

"In-Service Plants." Mill Creek 1, 2 and 3.

Low, George P. "The Generating, Transmission and Distribution Systems of The Edison Electric Company of Los Angeles, Cal.," *The Journal of Electricity, Power and Gas*. vol. XIII, no. 1. January, 1903.

[54] Hinson, op. cit., 58.

"Means Much to Redlands: Big Light and Power Deal Closed," *Los Angeles Times*. May 25, 1901, 8.

"Mill Creek #1 Hydro Plant: America's First Commercial 3-Phase Alternating Current Power Plant." [circa late 1980s].

"Monument Dedicated: Henry Harbinson Sinclair, Pioneer in Hydroelectric Work in West, Honored at Redlands," *Los Angeles Times*. February 26, 1927, 6.

Myers, William A. *Iron Men and Copper Wires: A Centennial History of the Southern California Edison Company*. Glendale, California: Trans-Anglo Books, c1983, 1986.

Owens, Charles. "The Birthplace of Hydroelectric Power," *Los Angeles Times*. June 8, 1924, G1.

"Property Data – Southern California Edison Company: Mill Creek No. 2 & No. 3 Power House."

"Redlands: Electric Light and Power Company is Reaching Out," *Los Angeles Times*. January 30, 1896.

"Redlands Electric Light & Power Co., Edition Electric Co. of Los Angeles, Mill Creek Powerhouses." *National Register of Historic Places Inventory – Nomination Form*, April 30, 1985.

"Redlands: New Power Plant," *Los Angeles Times*. May 25, 1902, 10.

Rushmore, David B. and Eric A. Lof. *Hydro-Electric Power Stations*. New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Limited, 1923.

Taylor, Thomas T. "Photographs, and Written Historical and Descriptive Data: Bishop Creek Hydroelectric System, Bishop Creek, Bishop Vicinity, Inyo County, California, HAER No. CA-145," February 7, 1994.

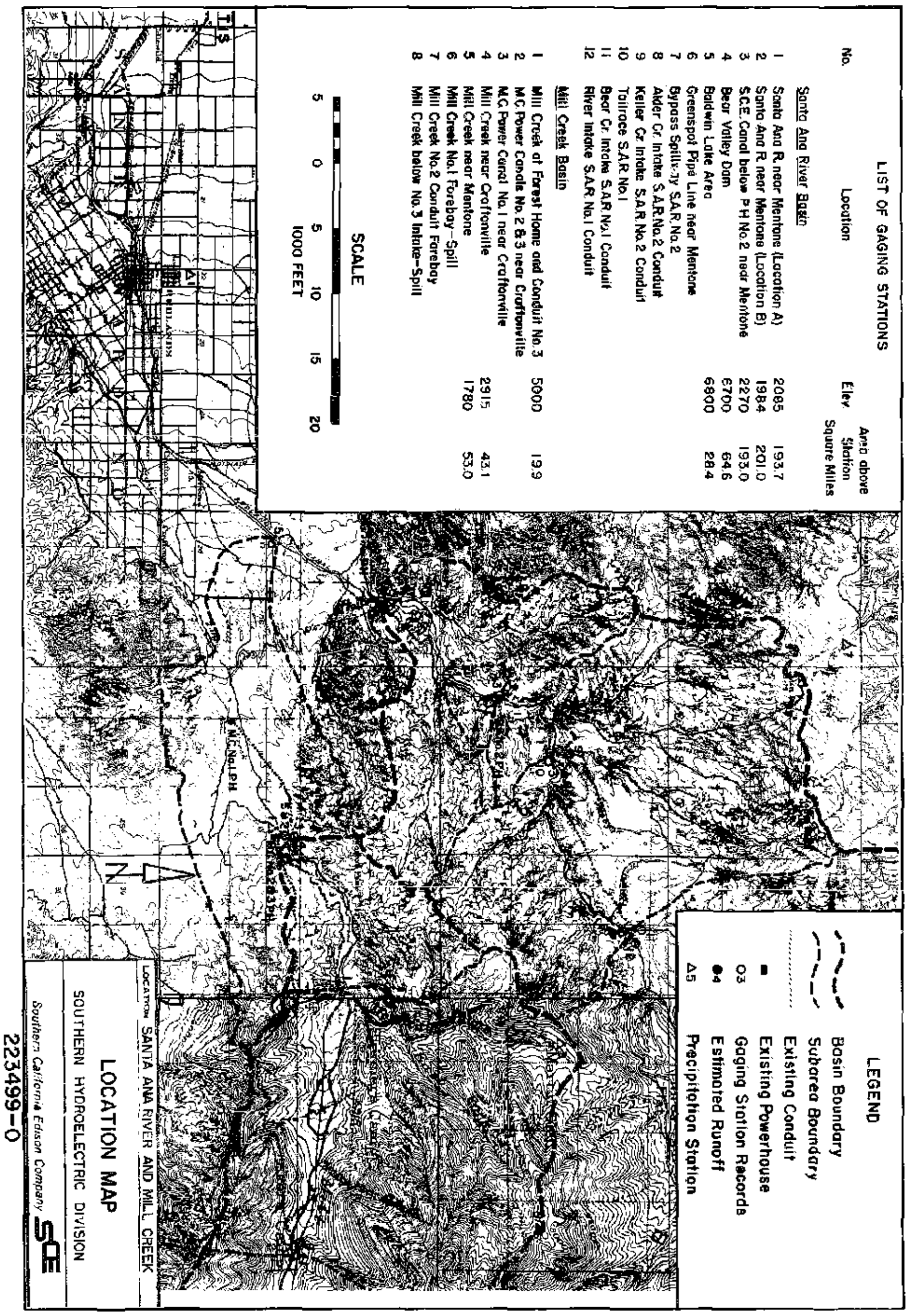
White, David R. M. "Cultural Resource Management Plan for the Southern California Edison Company Mill Creek Hydroelectric Project (FERC Project No. 1934) San Bernardino County, California," June 1993.

"Work on New Electric Plant," *Los Angeles Times*. March 27, 1899, 9.

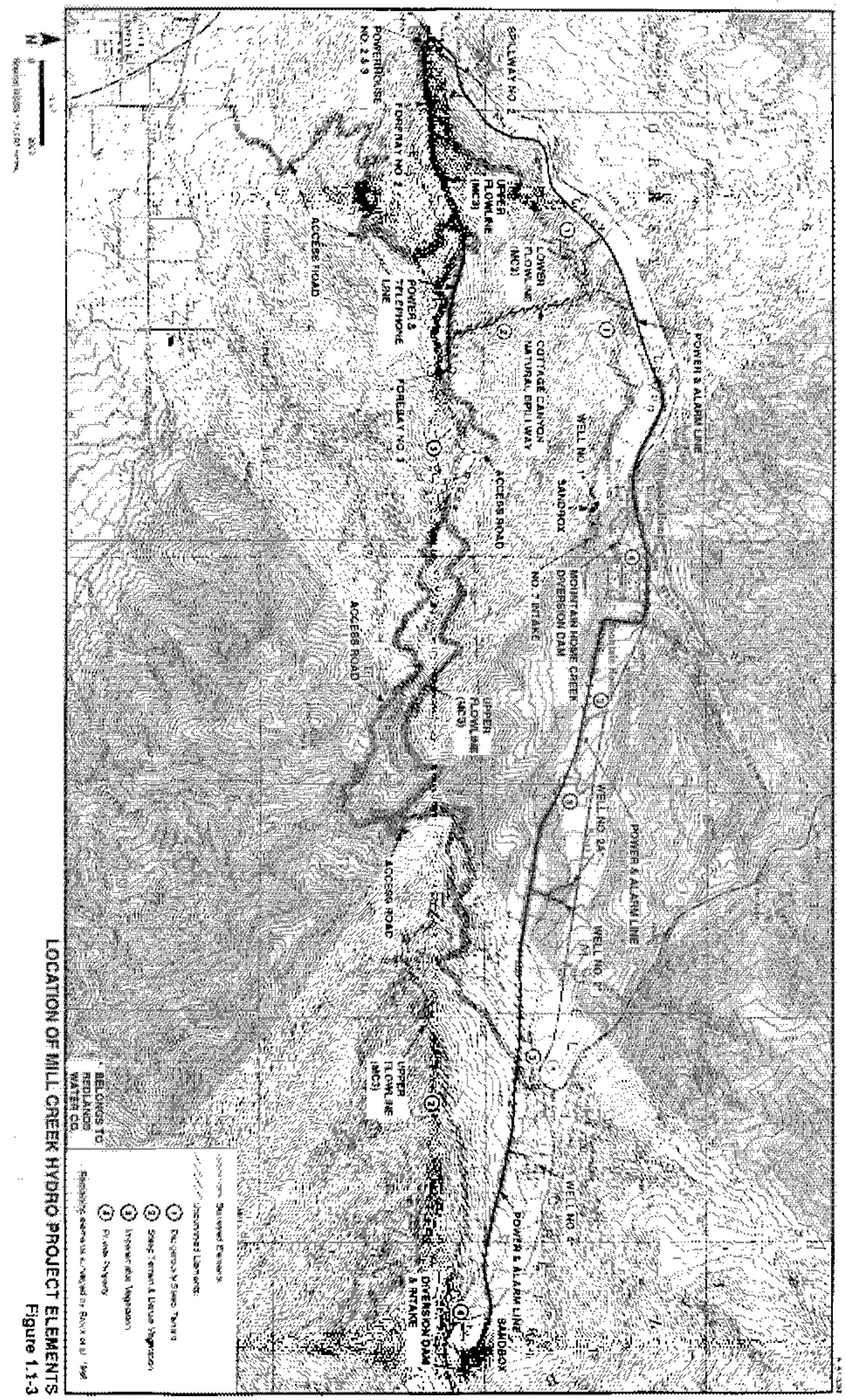
Note: Historic photographs of the Mill Creek 2 and 3 Hydroelectric Systems can be viewed at the Huntington Library located at 1151 Oxford Road, San Marino, CA 91108.

Part IV: Project Information

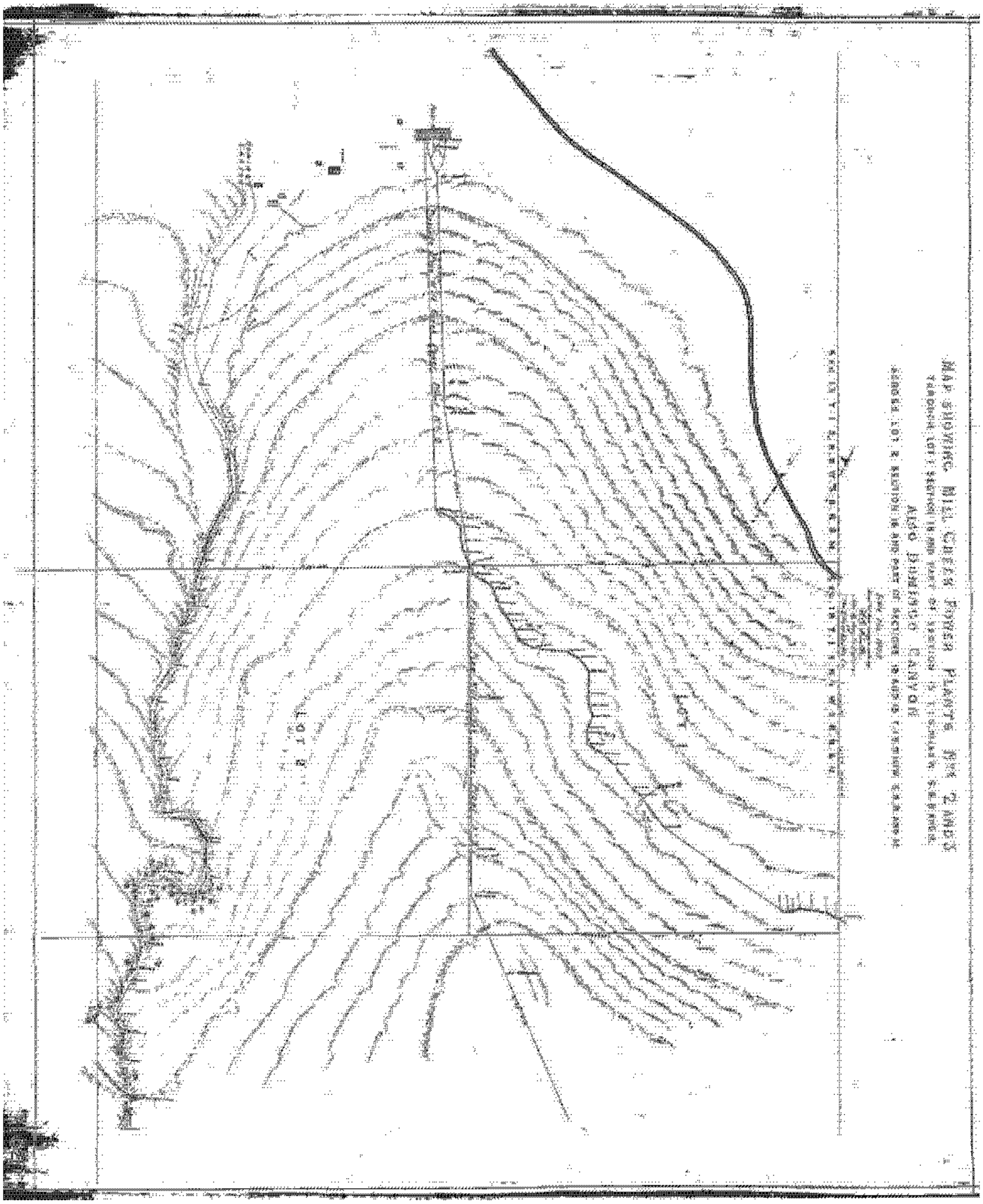
MC 2 has not operated since 1992 when it was damaged during floods. It was not, however, decommissioned. The Southern California Edison Company, in conjunction with the San Bernardino National Forest, the agency that owns the property, proposes to formally decommission the facility. This process will include filling the sandbox and forebay with slurry, and removing the metal features. Although MC 3 is still in operation, it is also being recorded as part of this project because of the system's close association with MC 2.



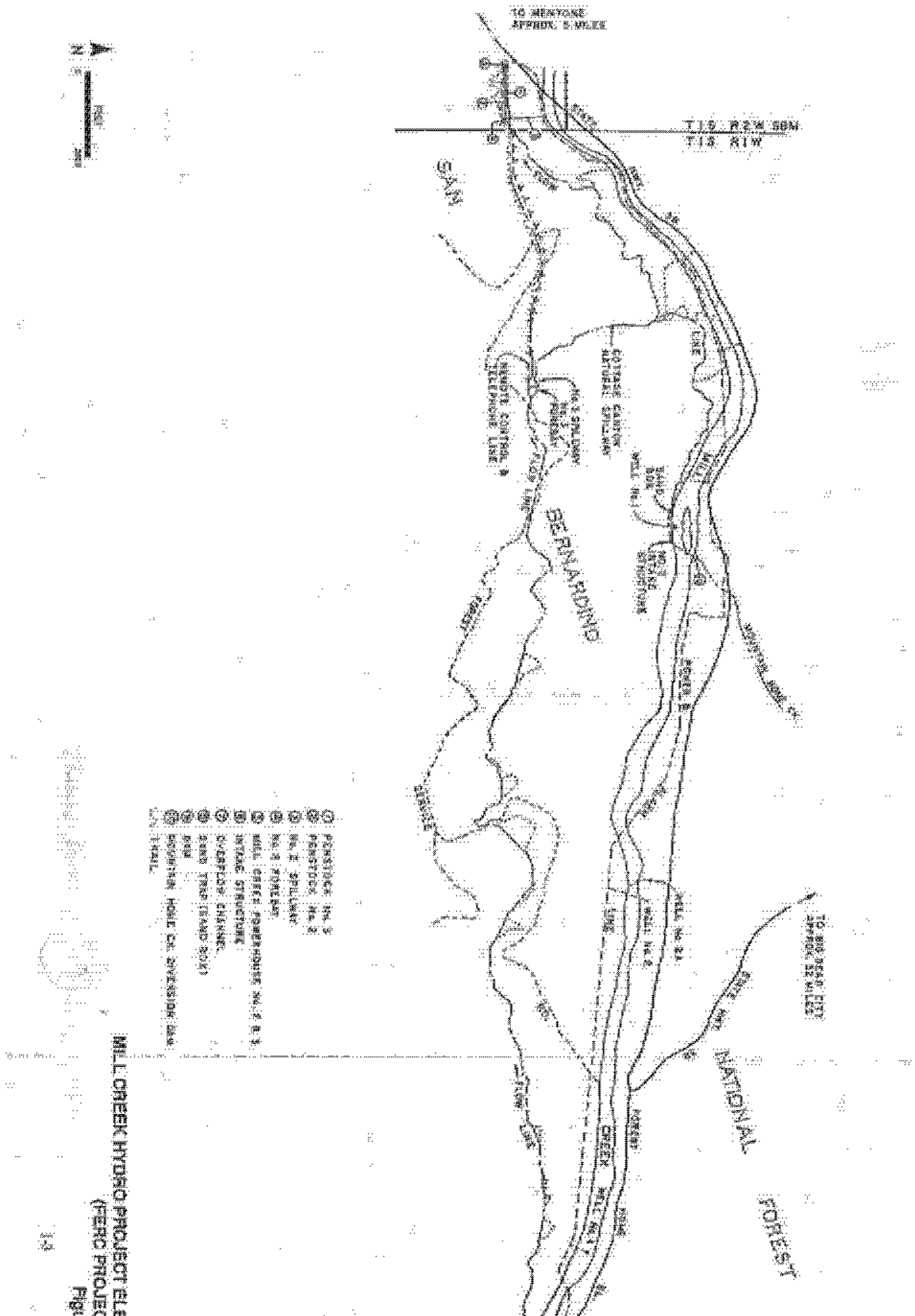
Location Map Identifying the Mill Creek and Santa Ana River Hydroelectric Systems. Map Courtesy of Southern California Edison.



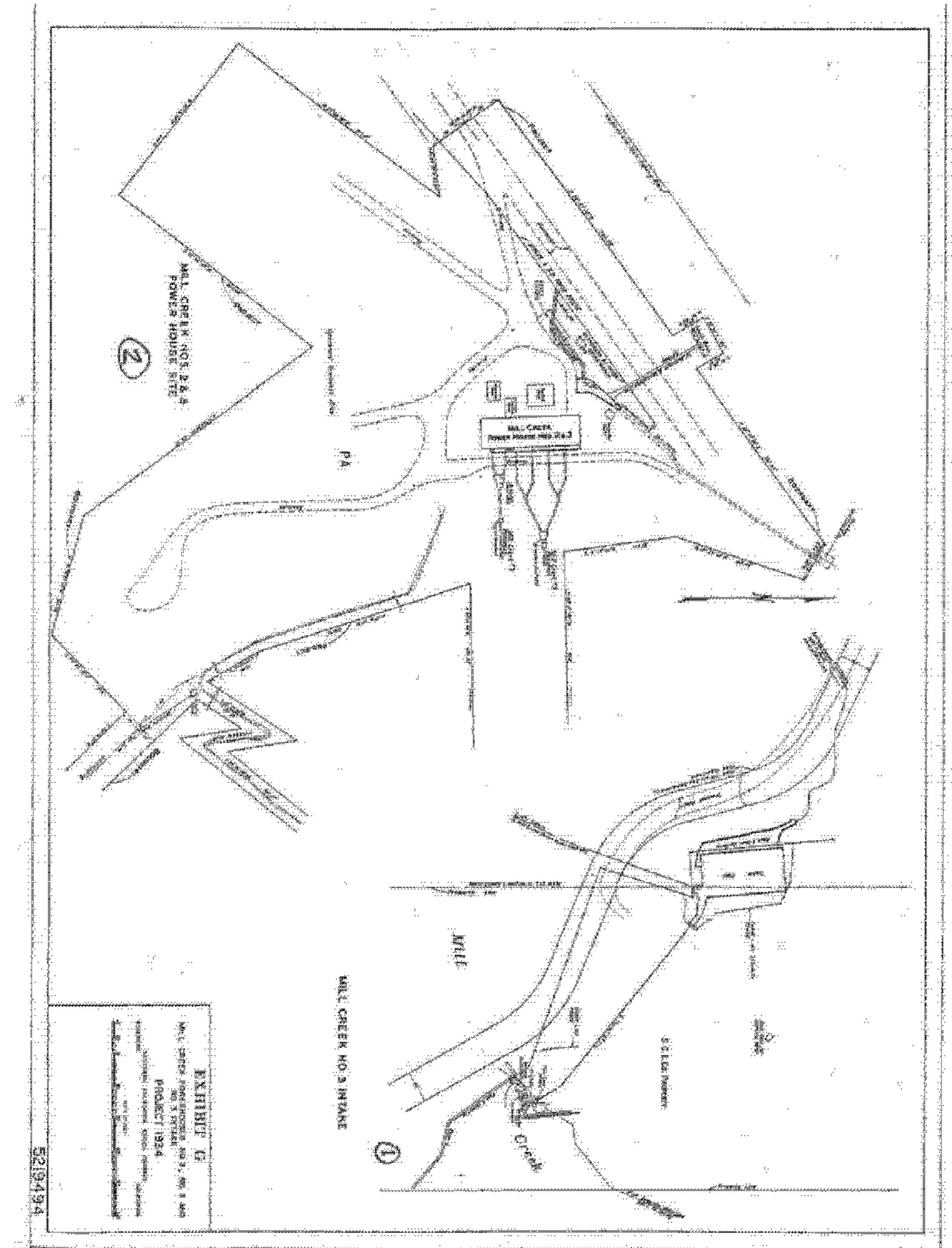
Location of Mill Creek Hydro Project Elements. (Map Courtesy of Southern California Edison)



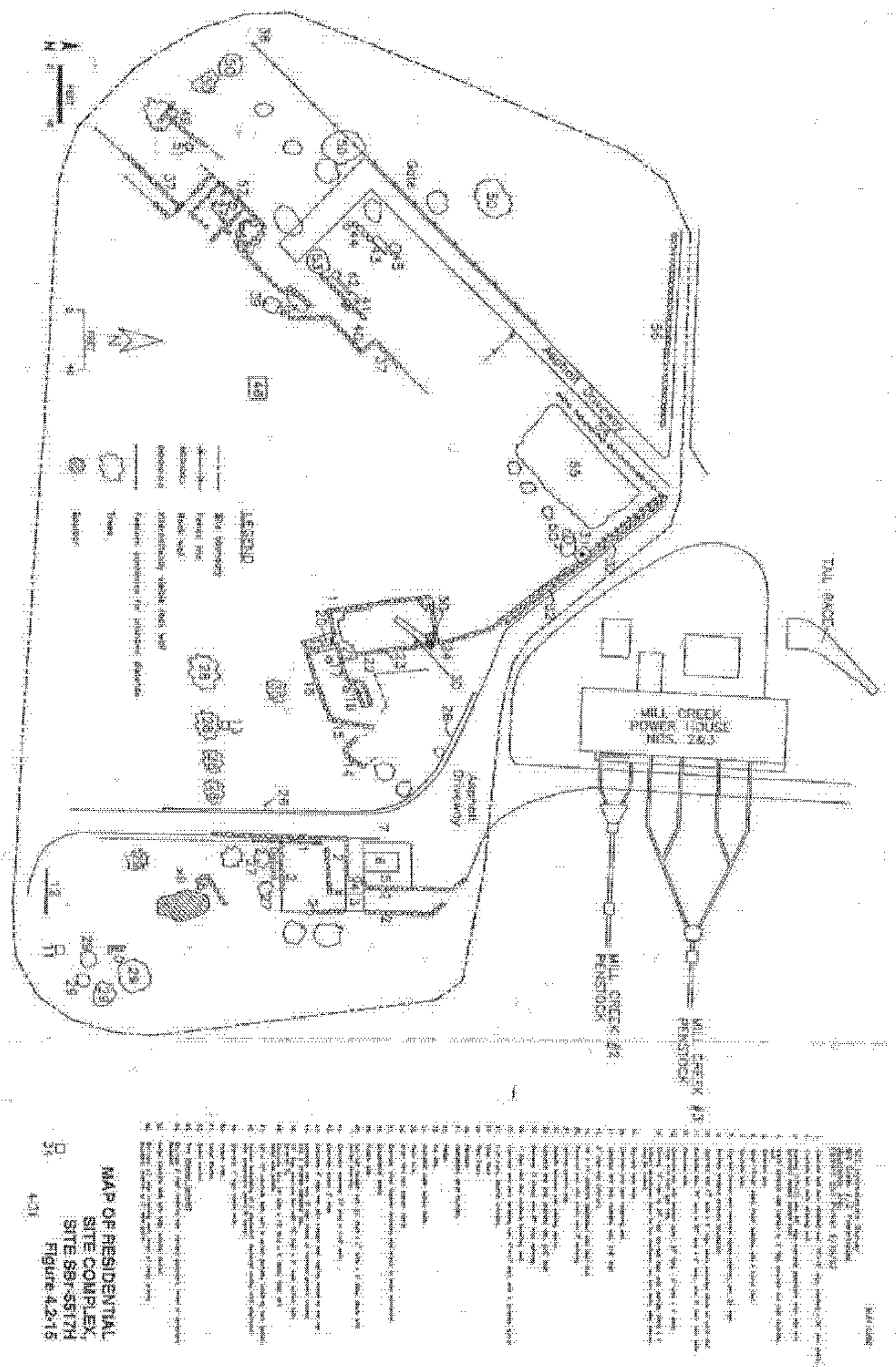
Overview map of Mill Creeks 2 and 3 from circa 1903 using data from surveys conducted by F.C. Finkle (Courtesy of Southern California Edison)



Overview of the Mill Creek Hydro Project Elements. (Plan Courtesy of Southern California Edison)



Overview Site Map of the Mill Creek 2 and 3 Powerhouse Site and Mill Creek 3 Intake. (Map Courtesy of Southern California Edison)



Site Map of the Mill Creek 2 and 3 Powerhouse Site (Map Courtesy of Southern California Edison)